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October 7, 2005

Ms. Iris Stanley
Division of Housing and Community Development
Florida Department of Community Affairs
2555 Shumard Oak Boulevard
Tallahassee, FL 32399-2100

RE: FINAL REPORT
Contract # 05RC-11-13-00-05-001

Dear Ms. Stanley:

In compliance with contract of the reference, I am pleased to herewith enclose our final report for the research project ***Hurricane Loss Reduction for Housing in Florida*** conducted by the International Hurricane Research Center (IHRC) at Florida International University (FIU). This report summarizes our research activities from July 1, 2004 through September 30, 2005. This report complies with the required reporting requirements per the contract agreement.

The IHRC team looks forward to continuing to work with you and to be of service to the residents of our state. Please contact me if you have a questions or comments.

Sincerely,

Stephen Leatherman
Director

International Hurricane Research Center
University Park Campus, Miami, FL 33199 • Tel: 305-348-1607 • Fax: 305-348-1761 • www.ihrc.fiu.edu

A Resource for the State of Florida

HURRICANE LOSS REDUCTION FOR HOUSING IN FLORIDA

FINAL REPORT
For the Period July 1, 2004 to September 30, 2005

A Research Project Funded by
The State of Florida Department of Community Affairs
Through Contract # 05RC-11-13-00-05-001

PREPARED BY
THE INTERNATIONAL HURRICANE RESEARCH CENTER
FLORIDA INTERNATIONAL UNIVERSITY

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Executive Summary

Like everyone who has watched the devastation of natural disasters, those of us who work everyday with the hard facts of hurricanes remain awestruck by the gravity of the 2004 and 2005 hurricane season. IHRC's focus on the mitigation of hurricane damage is made ever more resolute following the disasters brought upon the Gulf States this season. The Hurricane Loss Mitigation Program is making a critical contribution to the State of Florida by ensuring that the built environment will have a better chance of surviving future impacts from hurricanes. The IHRC can unequivocally state that our research capabilities and products have been enhanced as a direct result of continued HLMP funding.

This report highlights findings discovered through the dedication of over 25 researchers and students from four universities. Periodic communication via e-mail and telephone conferences has also contributed to keeping our effort on target and within established timelines. The below sections summarize stated objectives for the 2004-2005 research period. Each research finding and new mitigation technique will only be as effective as the response of governments and the public; hence, education and outreach are a very important component of our work.

Annual Report to the Florida Legislature

The IHRC assisted DCA in the preparation of a full annual report and accounting of activities under section 215.559, Florida Statutes, Hurricane Loss Mitigation Program. The report was submitted by DCA to the Speaker of the House of Representatives, President of the Senate, and the Majority and Minority Leaders of the House of Representatives and Senate on January 1, 2005.

Barriers to the Upgrading of Existing Mobile Homes and Communities

A major factor contributing to the degradation and, in some cases, the closure of mobile home parks is the inability of older parks to re-platt and/or upgrade to newer, safer units. Additionally, poor maintenance of individual mobile homes and deterioration of park facilities expedite this process. The physical condition of the park eventually results in the departure of park residents, which introduces economic degradation in the local community. In the end, market or economic and regulatory pressure may combine with these other factors leading to park closure, sale of the land and displacement of the resident population.

Over the last four years, researchers at the IHRC have identified a range of factors-including regulatory, political and socio-economic influences-that negatively affect mobile home parks in urban areas. Seven barriers and 21 recommendations were identified in the report.

Replacement Program for Existing Mobile Homes

The IHRC has assessed the total estimated cost and timelines associated with replacing all pre-1976 units currently located in mobile home parks in Florida. This past research included the identification of potential sources of funding for such a program as well as policy

alternatives that could be enacted through legislative action to make such a replacement program feasible and affordable. A report to DCA regarding the mobile home disposal program and policy alternatives was drafted under the established 2004/2005 research program. While the idea of a replacement program to reduce the number of older, pre-1976 mobile homes in Florida sounds promising in theory, the reality of implementing such a program in an effective and cost-efficient manner appears impossible.

Hurricane Loss Reduction Devices and Techniques

The Role of Impact Modifiers in Neighborhood

The pressure loading on low-rise buildings-which reside within the lowest 5% of the atmospheric boundary layer-is deeply sensitive to the turbulence characteristics of the wind field, which in turn, is dependent on the roughness of the upwind terrain. Accordingly, neighborhood layout and landscaping affect this phenomenon significantly and play a role in modifying the impact of hurricanes on a site- or neighborhood-specific basis. Such impact modification may be positive or negative, meaning that in some cases the specific feature may contribute to increased damage, while in other cases the design or external feature may reduce the potential for damage from hurricane impact.

Understanding the role of each design component could contribute to the development of knowledge that would be useful for architects, city planners, developers and home builders as well as public officials responsible for building design and construction or comprehensive planning. Two research projects were implemented to examine the role of design components and landscaping. The first report presents a study conducted to determine the wind-induced pressures on complex-shaped roofs of residential buildings located in suburban terrain. The focus of the work was an analysis of full-scale data collected during the hurricanes of 2004 to develop external pressure coefficients measured on six full-scale prototype houses. The study found general agreement between the mean external pressure coefficients obtained at full scale and at model scale. This research will form the basis of an ongoing study and further analysis to develop and compare area-averaged roof pressures from wind tunnel results with current ASCE 7-02 design provisions.

The second project examined the relationship between location and density of nearby vegetation and extent of residential building damage evident from Hurricane Andrew. Aerial photos, taken approximately 2 ½ weeks after Hurricane Andrew, were used to examine patterns of storm damage in residential neighborhoods for a qualitative visual assessment of the negative or positive effects of vegetation. Investigative work found that both the local extreme events seen in Hurricane Andrew and variable home construction methods significantly contributed to the extensive damage to residential property. As such, perhaps this storm was too catastrophic to be able to detect relatively modest effects of vegetation in this study. Anecdotal evidence suggests that proper vegetation can offer protection to houses; conversely the wrong trees improperly placed can add to the damage.

Performance Modifiers in the Mitigation of Roof Damage

As the components and cladding degrade during a hurricane episode, the likelihood of a breach in the building envelope increases, which can allow rain to enter the interior of the structure and internal pressure to contribute to uplift on the roof.

Improving the performance of the roof under the impact of hurricanes can lead to a significant reduction in potential damage and a reduction in the cost of future disasters in hurricane vulnerable regions. Research work at the IHRC over the past three years has shown that it is possible to develop new design criteria or construction methods and techniques or building products that will enhance the performance of housing under hurricane impact at a cost that is acceptable to the home-building industry. Two research projects were undertaken for this effort.

The IHRC's Wall of Wind project offers a revolutionary new concept in the field of structural damage mitigation research by allowing test specimens to be exposed to actual hurricane-force wind and rain at full-scale. Since its arrival and assembly, it has been operated at Miami-Dade County's Tamiami Park. During this time, work was performed on the development and calibration of the control and data acquisition algorithms and water penetration system. The use and operation of the Phase I prototype array has allowed for improvements to be made to the hardware and software needed to control the apparatus. The resources emphasized into Phase I of the project will ensure that the desired wind field will be produced. This effort translates into accurate testing that will ultimately serve to improve building techniques, thereby reducing the overall losses sustained by hurricane-prone communities.

A second project further examined fastener study research for site-built housing. One of the most common failures experienced by residential structures subjected to hurricanes is the loss of roof sheathing. Although the Florida Building Code has improved the consistency and quality of sheathing fasteners, fastening schedules still differ greatly statewide in homes built prior to the introduction to the 1995 code. These differences became particularly evident after Hurricane Charley struck the southwest coast of Florida in 2004. Damage assessments conducted by the IHRC found many homes constructed using staples to fasten sheathing to roof structural members. The extent of staple fasteners observed during recent damage assessments prompted the IHRC to perform panel uplift tests using staples in order to expand on testing undertaken in the 2003-2004 research year. Maximum uplift capacities were determined for sheathing secured by staples and compared to uplift capacities of 8d bright common nails tested in previous experiments and proscribed in building codes prior to the 1995 updates.

Statistical analysis was performed using the results to determine relationships between pullout pressures and fastener types. Both staple types had only about half of the pullout capacity of the Sheather Plus nail. The 1.5" staple leg staple had a mean pullout capacity of 67 psi while the 2" staple leg staple performed slightly better with a mean pullout capacity of 79 psi. The Sheather Plus nail performed exceptionally well with a mean pullout capacity of 140 psi, as compared to 106 psi measured with common bright 8d nails.

State-Wide and Focused Surveys to Assess Effectiveness of RCMP Program

A team of social scientists conducted field work and interviews in the areas of Port Charlotte, Punta Gorda and Arcadia during the first week after Hurricane Charley made landfall on August 13, 2004. Interviews were conducted in shelters, relief centers, disaster application centers, and citizens' homes, as opportunities and issues developed. An open-ended survey instrument was used, supplemented by taped and transcribed remarks. In total 100 interviews were conducted and 92 survey forms completed. While not a random sample, the attributes of respondents reflect a diverse cross-section of Floridians. In addition to these data, subsequent interviews with emergency managers in four counties, a FEMA official, two volunteers and broadcast meteorologists from four media outlets inform this report.

The findings provide insight into what some of the storm's most affected citizens were thinking prior to the storm, what protective actions they took, what they think they would do the next time, and how they are faring in the immediate aftermath. Research points to several issues for possible consideration by state and local authorities including: 1) People still do not understand hurricane track probabilities and pay too little attention to the entire cone of uncertainty, 2) "False experience" continues to be a problem in getting people to react appropriately to hurricane watches and warnings, 3) Renters are among the most vulnerable groups, and they make no preparations for hurricanes, 4) Residents of this area find little incentive to adopt hurricane mitigation measures 5) Emergency management at the state, regional and local levels appeared well coordinated and effective, especially given the circumstances of this hurricane's development.

FIU-Graham Center Hurricane Shelter Architectural and Engineering Design Study

During the Spring 2004 a retrofit programmatic technical assistance and hurricane shelter survey was conducted by DCA, Monroe County Emergency Management and Miami-Dade Emergency Management. The FIU E. R. Graham Student Center (GC) was identified as a potential public hurricane evacuation shelter for Monroe County residents. Pistorino & Alam Consulting Engineers, Inc. was retained by the IHRC to perform the preliminary structural engineering assessment of the original building and additions in order to establish the adequacy of this building to meet structural requirements established for a hurricane evacuation shelter. This study also included cost effective retrofit propositions for the structural systems, non-structural components and for the hardening of the building envelope as well as a benefit cost analysis.

The building can be effectively converted and improved to function as a temporary hurricane shelter. The hardening costs for providing internal partitions that isolate sections as well as protection for exterior glazing/glass wall openings is approximately $1,500,000. Up grading the building frame and roof openings and roof mounted mechanical equipment will also be necessary, and the budget estimated is approximately $1,750,000 depending on the actual retrofit requirements. The detailed engineering assessment will cost $150,000.

Programs of Education and Outreach to Convey the Benefits of Various Hurricane Loss Mitigation Devices and Techniques

This effort was built on the foundation of work initiated during the 2003/2004 grant period. Activities including outreach initiatives, such as the Deerfield Beach Hurricane Warning Project, the Governor's Hurricane Conference, the South Florida Hurricane Conference, and the Miami-Dade County Local Mitigation Strategy. In addition the Broward County Public Schools filmed the IHRC conducting impact tests for a piece entitled "The Sherlock Project: Weather & Technology". This segment was shown to all Broward County public schools as an interactive science lesson.

Research components were also complemented with digital techniques in order to provide a visual representation of the research findings. As part of a collaborative initiative, a visualization of wind tunnel-generated peak roof pressures was conducted for three prototype houses. The main focus of this research was to better understand the pressure variability on typical houses located in suburban locations. Final renderings of the houses and environments were composited with graphical elements using Maya 6.0, a 3d software package by Alias. This visualization will be used for future education and outreach initiatives.

IHRC Project Research Team

The 2004-2005 research team was comprised as follows:

Principal Investigator:	Stephen Leatherman	FIU/IHRC
Project Manager:	Carolyn Robertson	FIU/IHRC

Principal Researchers:

Nicole Dash	UNT	Sociology
Rosina Killian	FAU	Electronic Communication
Forrest Masters	FIU	Wind Engineering
Betty Morrow	Consultant	Sociology
Dario Moreno	FIU	Political Science
John Pistorino	Consultant	Vulnerability Assessments
David Prevatt	Clemson	Civil Engineering
Christian Resick	FIU	Psychology
Edmund Skellings	FAU	Electronic Communication
Keqi Zhang	FIU	Environmental Studies

Research Assistants:

Collette Blessing	FIU	Civil Engineering
Russell Carter	Clemson	Civil Engineering
Peter Datin	Clemson	Civil Engineering
Pat Houle	FIU	Environmental Studies
Zhuzhao Liu	Clemson	Civil Engineering
Frank Preito	FIU	Civil Engineering
Kenneth Randall	FIU	Psychology

Undergraduate Students:

Randall Blanchette	FIU	Civil Engineering
Victor Camps	FIU	Architecture
Marcio Coelho De Souza	FIU	Computer Science
Alex Cuesta	FIU	Computer Engineering
James Erwin	FIU	Civil Engineering
Brie Losego	FIU	Architecture

Support Staff:

Natalie Defraene	FIU	IHRC
Kathy-Ann Decle	FIU	IHRC